Reducing embodied environmental impacts of buildings
Policy options and technical infrastructure

By Jennifer O’Connor and Matt Bowick
Athena Sustainable Materials Institute
Abstract
This white paper explores different policy directions and explains the technical pieces required to support the effective use of life cycle assessment (LCA) and embodied carbon in green building programs and policy, and to support good practice in whole-building LCA in general.

Acknowledgments
The Athena Institute thanks its members and other funders for enabling this white paper. In addition, the authors thank Jordan Palmeri at the Materials Management Program, Oregon Department of Environmental Quality, for his very helpful review of this paper.

About the Athena Institute
The Athena Sustainable Materials Institute is a non-profit research group that advocates for environmental performance measurement and accountability in the built environment. The Athena Institute is the North American leader in LCA for construction and its materials and has been providing ground-breaking research and free resources since 1997.

www.athenasmi.org
info@athenasmi.org

Help support our program
For our work in the common good, we rely on a network of support. Our LCA education efforts, our free software tools and information resources, and our assistance to green building policy and programs have had real impact—and wouldn’t be possible without funding from other sustainability leaders. Help us continue to provide our public service by joining the Athena Institute as a member or a donor: www.athenasmi.org

Cover photo: Ashley Fisher License: CC BY-SA 2.0
Reducing embodied environmental impacts of buildings: Policy options and technical infrastructure

CONTENTS

Why embodied impacts are the next frontier ___________________________ 4
Approaches to policy ________________________________________________ 5
The technical infrastructure ________________________________ 8
Next steps __________________________________________________________ 15
WHY EMBODIED IMPACTS ARE THE NEXT FRONTIER

Green building policy – codes, standards, regulations, and market incentive programs like LEED® – are evolving worldwide. Policy is moving towards data-driven approaches that emphasize verifiable, measurable performance outcomes.

There has been much effort and success over the past few decades to address what is traditionally viewed as the biggest contributor to the environmental impact of buildings: the energy required to operate them.

The next frontier is everything else. As building performance approaches zero energy or zero carbon for operation, the upstream and downstream impacts of building material manufacturing, building construction, building maintenance, building demolition, and end-of-life waste management become the most important targets for reduction. These are the embodied (versus operating) impacts.

Even with conventional construction, the upstream embodied impacts are much more significant than many people realize, particularly if climate change urgency encourages action focused on short-term results. See Figure 1.

![Figure 1 Carbon footprint of a typical building after 10 years of occupancy](image)

How important is it to immediately address embodied impacts? Carbon-aware architect Larry Strain sums it up well: “Because emissions are cumulative and because we have a limited amount of time to reduce them, carbon reductions now have more value than carbon reductions in the future.”² The World Green Building Council frames the problem as part of the climate emergency: “We must take urgent action to tackle upfront carbon while designing with whole life carbon in mind.”³

---

¹ This graphic is illustrating the proportional contribution of embodied and operating greenhouse gas emissions to the cumulative carbon footprint at approximately year ten in the life of a typical mid-rise building in Toronto. Data source: a comprehensive Athena Institute whole-building LCA study (see “Life cycle assessment for sustainable design of precast concrete commercial buildings in Canada,” M. Marceau et al, 2012).


Ideally, results-based policy will motivate:

- Reduced consumption of all resources (materials, energy and water) in all life phases.
- Continued life cycle impact improvements by manufacturers of all materials.
- Life cycle impact improvements in all buildings and infrastructure – new and existing.

For policy to succeed in measurably delivering those results requires the incorporation of life cycle assessment (LCA) in policy instruments. This in turn needs an extensive support system of LCA technical resources. In North America, much of this already exists. But as LCA-based policy evolves from the simple awareness-building phase to policies with real consequences, further technical resources need to be developed. We discuss the necessary technical infrastructure later in this paper.

**APPROACHES TO POLICY**

Sustainability thought leaders are recognizing the increasing importance of reducing cradle-to-grave impacts like embodied carbon and are working to motivate a behavioral shift in the development, design, construction and manufacturing sectors. This is why LCA appears in some green building programs and policy.

Specific mention of “embodied carbon” as the primary focus for a life cycle assessment is starting to emerge globally in policy. Ambitious goals for embodied carbon reductions are being stated. **This is a new landscape for green building policy.** As policymakers explore and experiment with embodied carbon policy, they will likely be considering one or more of the following fundamental approaches:

1. Requirement or incentive to simply measure and report embodied carbon.
2. Financial incentive to reduce absolute impacts: for example, an embodied carbon fee.
3. Requirement or incentive to reduce impacts relative to a customized performance target.
4. Requirement or incentive to meet a fixed performance target.
5. Requirement or incentive to use prescribed materials or design measures.

In the remainder of this section, we briefly describe each of these five policy approaches from the perspective of LCA support capacity and possible technical pitfalls. Note that determining exact policy instruments and how to implement them is outside of our scope of expertise and not addressed in this paper. Note as well that, while we provide a few examples of existing policies, we are not providing a review of those policies.

1. **Simple disclosure**
   A gentle first step to embodied carbon policy is to simply request measurement and reporting. Proposed building projects would undergo an LCA study (perhaps at various phases through design and construction) and would disclose the results. This approach is used by the **City of Vancouver**, in its Green Buildings Policy for Rezonings, and in the Canada Green Building Council (CaGBC) **Zero Carbon Building** program. Because the consequences of this approach are minor, it is well-supported by existing whole-building LCA tools and their underlying data and methods. A big benefit of implementing a long simple disclosure phase is that it allows time for the target audience to build up skills and awareness about whole-building LCA – there is a learning curve to climb. Increased LCA awareness may motivate more use of LCA in manufacturing and more transparency documents like environmental product
declarations (EPDs). Formalized reporting also creates an opportunity to gather relevant data like whole-
building LCA results and bills of materials for use in crafting future policy instruments and benchmarking
tools. This experimental phase will also reveal market hurdles to the practice of whole-building LCA, as
well as technical issues needing resolution, such as data gaps, methodology questions and variability and
uncertainty in results.

2. **Embodied carbon fee**
A financial incentive like an embodied carbon fee is perhaps the purest and simplest way to drive down
embodied impacts. Projects pay a fee per unit of embodied carbon (and perhaps for other
environmental impacts) and therefore would be motivated to reduce the fee. This approach is well-
supported by existing whole-building LCA tools and their underlying data and methods. An embodied
carbon fee forces teams to acknowledge that all buildings have embodied impact, regardless of any
apparent sustainability characteristics. The purity of this approach is in the recognition of absolute
(total) carbon impacts – how much GHGs the atmosphere sees due to this building. This is in contrast to
a carbon intensity approach (GHGs per unit of floor area), which is an expression of efficiency but tells us
nothing about the total carbon emissions. The *Living Building Challenge* has taken this route in requiring
the purchase of a carbon offset for the embodied carbon in a project. Ideally, this approach should be
accompanied by hard rules on how to calculate embodied carbon to avoid “cheating,” but this isn’t
critical. A carbon fee is easy to understand, good for creating awareness, and likely quite effective in
delivering real results – if the fee is high enough. A possible win-win cost-neutral scenario is a project
where low-carbon materials with a price premium are covered by a reduction in the embodied carbon
fee. For an innovative multi-pronged approach, a jurisdiction would use the collected fees from new
construction to provide financial incentives for building preservation.

3. **Customized performance target**
A number of green building programs including LEED and Green Globes use a customized approach,
with a self-defined “baseline” or “reference” building design serving as the performance target (e.g., a
design alternative or an existing project). While helpful in building LCA awareness and skills, there is a
lack of hard guidance on how to produce a baseline/reference, and it is impossible to verify whether
beating the baseline/reference is meaningful. Instead, a custom performance target should be crafted
around a “benchmark,” which is quite different from a self-defined baseline/reference. A benchmark is a
target customized for a project based on a statistically derived average for the existing building stock.
This is the best approach when wanting to track performance against business-as-usual and seeking
evidence that a policy is working. That is, provided that the benchmark is well-established and a method
for appropriate comparison is in place – otherwise, this approach is easy to game. A reliable benchmark
system would be similar conceptually to the ENERGY STAR program, where operating energy intensity is
compared to peer facilities. Crafting a rigorous, defensible whole-building LCA benchmarking system is
harder than it seems. The Athena Institute is in the process of implementing the first such system in
North America, per a stakeholder-reviewed and pilot-tested methodology\(^4\). For this system to work, a
number of technical components must be in place, including whole-building LCA practice guidelines to
ensure that comparison to a benchmark is accurate and fair, and a data source for establishing
appropriate benchmark targets. These components are still in development.

---

4. **Fixed performance target**

While appealing for its conceptual simplicity, a fixed performance target is difficult to implement and just as easy to game as other approaches. In this method, a performance cap is set – for example, projects must not exceed 500 kg of embodied carbon dioxide equivalent per square meter of gross floor area. This is the approach used in the *International Living Future Institute Zero Carbon Certification* program (which additionally requires purchase of an embodied carbon offset and reduction of embodied carbon relative to a self-defined baseline). This method can only work if the fixed performance cap is derived in a statistically valid manner and the guidelines for performing LCA are exceptionally well-defined; if not, any comparison to the target is meaningless. Neither condition is currently in place. Comparability is a big challenge for two key reasons. First, a single fixed target will never be appropriate across all building types, in all regions, with all whole-building LCA software tools; instead, multiple targets would have to be provided to cover those variables. Second, details of the LCA modeling process for the building of study – scope, boundary, assumptions, time frame, data sources, life cycle impact assessment method, and so forth – need to exactly match the process used in generating the performance target. That requires a very detailed and comprehensive whole-building LCA practice guide. The ILFI Zero Carbon program provides minimal LCA modeling requirements (meaning it is highly likely that results will be non-comparable to the cap) and sets a cap (500 kg CO₂e per square meter) based on a source that is inappropriate for this purpose. We recognize that the ILFI program is purposefully pushing the envelope in order to show leadership, create awareness and drive change. Ideally, this program would also be a motivator for developing the technical infrastructure needed to support the effectiveness of the policy in genuinely reducing embodied carbon. This would be helped if the program acknowledged the “alpha” state of the embodied carbon cap and flagged the issues that hinder comparisons and require further work.

5. **Prescriptive approach**

A prescriptive approach would identify specific materials or design measures that are deemed to be beneficial for embodied carbon. There may be strong appeal for this approach due to its simplicity. However, there are some serious drawbacks and potential unintended consequences to consider. First, note that a prescriptive approach is the opposite of a performance approach and therefore LCA has no role here other than to perhaps provide rationale for ranking materials by environmental preference. There is no project-specific whole-building LCA happening in this policy approach, which means it is impossible to validate total carbon reduction effectiveness. For example, the Architecture 2030 *Carbon Smart Materials Palette* advocates for some materials prescriptively, but, while delivering useful information on materials, it does not provide a scientific basis for material selection. Additionally, evaluating materials outside the context of a whole building risks missing trade-offs with other building components and across the full life cycle of the building. Prescriptions create a false sense that there are silver bullets for low-impact buildings, taking pressure off the project team to look for improvements along the full value chain and the full life cycle scope of the building. This can potentially lead to a building that is actually worse than business-as-usual. Note as well that prescriptions that choose favorites across competing materials will remove incentive for any material to improve and causes ill will.

---

5 Simonen, K., Rodriguez, B., McDade, E., Strain, L. (2017) Embodied Carbon Benchmark Study: LCA for Low Carbon Construction. Available at http://hdl.handle.net/1773/38017. In this survey of LCA studies for over 1000 buildings, the authors are confident that the survey provides a reasonable order of magnitude and range of possible whole-building LCA results; however, they clearly note a lack of consistency across the studies, gaps in life cycle stages and building types, and lack of statistical representativeness, which means the results cannot be used for averaging, comparisons or benchmarking.
by creating winners and losers among the material industries. However, there may nonetheless be a place for limited prescriptive policy, ideally intra-industry – for example, addressing concrete mixes.

THE TECHNICAL INFRASTRUCTURE

Embodied carbon policy needs a strong foundation to reliably deliver environmental benefits. There is a high degree of uncertainty in LCA results for a long-lived and complicated product like a building, due to difficulty in predicting the future and due to issues with data gaps and quality, among other factors. The uncertainty can be reduced through improvements to the underlying technical infrastructure, enabling implementation of new policies.

Whole-building LCA requires a whole ecosystem of technical resources, as illustrated in Figure 2. There are many pieces of this already in place in North America. Current resources are effective in introducing LCA to the green building community. Design students and professionals are developing LCA skills and using LCA to advance their sustainability practice.

North America has what it needs to support “soft” LCA-based policy. For example, green building policy and programs that simply require design teams to perform LCA and report the results. This is useful for pulling the community up the steep whole-building LCA learning curve and for identifying technical gaps and market hurdles that will get in the way of policy evolution.

The next step is policy with teeth. This could be a requirement that design teams achieve environmental reductions over business-as-usual and validate their claim with LCA. Or it could involve putting a price on embodied carbon.

The technical infrastructure isn’t quite ready to support policy that has real consequences. In our opinion, there are too many gaps and too much uncertainty in the system to assure that such policy will lead to actual environmental benefits. A number of other LCA researchers have come to the same conclusion.

We strongly advocate for public investment in LCA technical infrastructure. A robust system of resources and capacity will support comprehensive sustainability activity in manufacturing, design, construction, procurement, and policy development.

---

Figure 2  Whole-building LCA infrastructure and use pathways
The goal for whole-building LCA technical infrastructure is to ensure reliable, comparable whole-building LCA results across practitioners, software platforms, and projects. Reliability, consistency and comparability must be in place for LCA-based policy to drive validated environmental performance quantification and improvements.

There are six critical elements of whole-building LCA technical infrastructure:

1. Standards
2. Data and methods
3. Software tools
4. Performance datums (benchmarks and baselines)
5. Guidelines
6. Education and other outreach

We briefly discuss each one below. For a more extensive and technical review, please see a report we completed for the National Research Council Canada as part of the kick-off for a national LCA initiative⁷.

1. Standards

What this is: Standards are “documents that provide requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose.”⁸ In other words, standards provide a set of rules that everyone can follow to maintain consistency and avoid confusion in how things should be done.

Relevance: Standards are important in whole-building LCA because they theoretically can help harmonize practice by narrowing the opportunity for widely diverging interpretations of methods.

Current status: There are existing standards relevant to whole-building LCA. These broadly address how to conduct product-level LCAs and how to incorporate that information at the building scale. The current most internationally recognized LCA standard for whole buildings is EN 15978:2011⁹ and for building products is ISO 21930:2017¹⁰.

What’s missing: Existing standards are incomplete to comprehensively support North American LCA-based policy by themselves, as they are not intended to provide requirements or guidelines on meeting specific purposes of the practice. The gap can be filled with guidelines that align with standards.

---


¹⁰ ISO 21930:2017 Sustainability in buildings and civil engineering works — Core rules for environmental product declarations of construction products and services.
2. Data and methods

What this is: Underlying environmental data sets and assessment methodology are the foundation of whole-building LCA results. At the core is life cycle inventory (LCI) data for the materials, products and energy used in the building. LCI data is the result of an accounting model of the material and energy flows to and from nature that are associated with a product or process. For a product, these data typically represent a cradle-to-gate model and list quantities for hundreds of emissions, resource and energy flows. These data may represent a single manufacturer in a unique region or multiple manufacturers of the same product across a number of regions. Applying a consistent methodology when creating product LCI models is key to achieving a meaningful result. Life cycle scenarios are another data set used in whole-building LCA. This information is about product transportation, product replacement rates and other assumptions applied in determining the LCI for the gate-to-grave life cycle phases. Life cycle impact assessment (LCIA) method is the modeling approach used to characterize and quantify potential environmental impacts due to the LCI. The data and methods that underlie whole-building LCA require frequent updating.

Relevance: Established data and methods are important to making whole-building LCA practice feasible, consistent and reliable. Ideally, these data would reflect a consistent LCA methodology, be regionally applicable to the building’s location, and of the same or similar vintage such that they draw on similar upstream LCI data for common processes (e.g., electricity profiles, fuel combustion processes and transportation inputs). Earlier attempts in North America at establishing a national LCI database (the USLCI database) resulted in useful data but in the end faltered due to lack of funding and inconsistent monitoring and verification processes.

Current status: Currently, there is no viable open source LCI dataset applicable to N. America. Hence, LCA practitioners have been drawing on commercially available datasets and their own proprietary datasets, leading to varying outcomes. Harmonization of methods and LCI data at all geographical levels is critical for reducing the current level of inconsistency in LCA models, whether they are product or whole-building models. In addition, LCI data is missing for some important products and processes in all the databases.

Scenario data currently comes from the practitioner (e.g. known transportation distances for products) or the default values (generally industry-average) from software. Some default scenarios used by software lack a good statistical basis.

There is an existing LCIA method consistently used in North America, known as TRACI, which was developed at the US Environmental Protection Agency. This method is well-established, although note that it does not cover all impact categories of potential interest, for example “land use.” This is an area for future work.

What’s missing: There are many significant material and process data missing (for example, HVAC systems). There is no reliable and complete open LCI data source for North America, nor is there open scenario data. TRACI is missing some impact indicators.

11 EPA’s Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), see: http://www.epa.gov/nrmrl/std/sab/traci/. TRACI 2.1 released in March 2012.
3. Software tools

What this is: Software tools specifically created for whole-building LCA have the complex LCA methodology and the underlying data built into the software. This enables non-LCA experts like architects and engineers to produce LCA results.12

Relevance: Specialized whole-building LCA software tools are important because without them, whole-building LCA would not be feasible on a wide-spread basis. It would be too difficult to locate relevant data, would require access to professional LCA software (which is typically expensive), and would require expertise in the practice of LCA in general.

Current status: The predominant software tools currently available for North American projects are the Athena Impact Estimator for Buildings and Tally. Note that each uses different underlying LCI data, different life cycle scenarios, and different interpretations of whole-building LCA best practice.

What’s missing: Existing software tools all have room for improvement. Examples of future directions might be more intuitive user interfaces, interoperability with multiple third-party software tools, more default data to better enable early decision-making, more customizable modeling, uncertainty analysis, built-in benchmarking, help with results interpretation, and suggestions for user actions to improve results. It may additionally be helpful if tools eventually harmonized in method and underlying LCI and scenario data so that results from different tools would be more comparable.

4. Performance datums (benchmarks and baselines)

What this is: Whole-building LCA often relies on comparative analyses to make sense of how a project being evaluated is performing. “Baselines” “and benchmarks” are two types of performance datums used for this purpose. Baselines are designs generally produced by the assessor. These may come from a previous project, a building archetype, or a design iteration of the proposed project. In contrast, benchmarks are designs that are derived from statistical analysis of a sample set of buildings. Generally, this will aim to be an “average performance” that reflects the contemporary building stock or perhaps the collective buildings a design firm has worked on.

Relevance: Baselines and benchmarks are crucial aspects of whole-building LCA practice, particularly for setting performance targets for green building programs and policy. See Figure 3 for a generic example of how results could be used in policy. In this case, the proposed building results are normalized to the benchmark/baseline and the policy requirement is a 10% reduction relative to the baseline/benchmark for each of the six environmental indicators.

12 Simplified building-specific software tools like the Impact Estimator and Tally are not to be confused with professional all-purpose LCA software like SimaPro and GaBi, which serve an entirely different user group.
**Current status:** Existing approaches to whole-building LCA performance datums in policy are inadequate. Most of the North American green building programs with whole-building LCA-based performance incentives currently use a “baseline building” approach, where the baseline design (performance datum) is defined by the user. If the self-defined bar is set very low, then clearing it isn’t a meaningful achievement. It is generally agreed that benchmarks are a much better choice for policy, as they provide a reference point to gauge whether or not a building is performing better than business-as-usual. Performance against a benchmark is the objective evidence of policy success (or failure). The use of benchmarks in policy in North America is not well developed yet. For example, one program sets a fixed ceiling for embodied carbon, but the rationale for selecting the ceiling value is weak and there is no guidance to ensure fair comparisons to the ceiling\(^{13}\), so this cannot be considered an effective benchmark solution.

**What’s missing:** An appropriate and robust benchmarking system should rely on a defensible set of background data which can derive customizable performance datums, based on building type, location, assessment scope, etc. Benchmarks derived from this infrastructure should above all aim to reflect business-as-usual construction practice. This is a technically feasible goal in the near term, and the Athena Institute is actively working on it.

## 5. Guidelines

**What this is:** Guidelines would provide definitive and comprehensive instruction for the practice of whole-building LCA, keyed to various purposes for the study. Guidelines would be periodically updated, as methods and standards evolve.

**Relevance:** Guidelines are critical for standardizing whole-building LCA practice. Conducting a cradle-to-grave LCA for a complex and long-lived product like a building involves many decisions and assumptions that easily lead to inconsistency and non-comparability of results. Guidelines reduce the room for

---

\(^{13}\) This program is the ILFI Zero Carbon Standard, previously discussed in this paper, which is the first green building program in North America to set a ceiling for embodied carbon per square meter of project floor area.
variability in user judgements and set a standard for assessment quality, which improves comparability across studies and thereby enables the development of robust benchmarks.

**Current status:** Currently, there exist a few documents addressing high-level whole-building LCA guidance. In our opinion, none provide the level of detail required for standardizing practice and facilitating comparability.

**What’s missing:** Comprehensive, application-specific guidelines developed in alignment with standards and current best practices. This is an active area of work at the Athena Institute – we are currently developing such guidelines within a major Canadian LCA initiative\(^{14}\).

6. **Education and other outreach**

**What this is:** Whole-building LCA outreach would comprise a suite of tactics to build awareness, show value, develop skills and create demand.

**Relevance:** Outreach is important because whole-building LCA is a complex practice with a substantial learning curve for new users. In addition, where there are not strong market drivers like regulations or financial incentives, outreach can help create market demand if value can be demonstrated.

**Current status:** Currently, whole-building LCA outreach is weak. There is some activity by the Embodied Carbon Network, the Athena Institute, the commercial whole-building LCA software tool providers and a few other advocates, but it is insufficient, in our opinion.

**What’s missing:** A big gap in outreach is basic LCA education, so users of the whole-building LCA software tools understand what the results mean. Also needed: training in the tools; case studies and pilot tests to demonstrate how whole-building LCA works and how it brings value; and high-level awareness-building activities to introduce new audiences to the concepts and the language of LCA.

**Sidebar: Where EPDs fit in**

Environmental product declarations (EPDs) are third-party verified documents that summarize the results of a product LCA. There are many EPDs available for construction products (industry-average EPDs that represent a product group as well as brand-name manufacturer-specific EPDs). This is likely motivated by an incentive in many green building programs for design teams to specify products that have an EPD.

EPDs are an interesting vehicle for transparent disclosure but are not (yet) an integral part of the technical infrastructure described in this paper as necessary for support of embodied carbon policy.

EPDs report LCA results. This is different than the LCI data needed for a whole-building LCA as described in this report and illustrated in the figures. The LCA results reported in an EPD are derived from an LCI, which is typically not included in the EPD (it would be documented in the extensive LCA report behind the EPD).

To combine EPDs for a whole-building LCA result requires that the EPDs be consistent and comparable. This is not currently the case. Different background data sources, variations in data quality, and LCA method are just a few of the factors that make it difficult to compare EPDs. To evaluate products within a whole-building LCA, the most reliable approach uses LCI data to adjust for regional differences and to harmonize background data and LCA methodology.

Given the lack of harmonization between programs in North America, using EPD data for whole-building LCA is possible only if a large number of criteria are met. This may require expertise and/or tools that the layperson does not have. Nonetheless, it is theoretically possible to use EPDs in place of LCI data, recognizing that this may have ramifications on quality and uncertainty of the whole-building LCA results. In short, EPDs may contain environmental data that is more project-specific than industry-average LCI data sets (e.g., the use of a company-specific EPD of a product being specified for a project), however, until EPDs become more mutually consistent and consistent with North American LCI databases, this practice is fraught with methodological and scope issues and is not recommended.

Regardless, EPDs have value as a demonstration of transparent communication and as a signal to the marketplace that the manufacturer is using LCA to understand product impacts. Creating EPDs requires significant investment by industry, which is a notable contribution to the sustainability cause.

**NEXT STEPS**

In this paper, we have identified technical requirements and possible pitfalls for various embodied carbon policy options. Our recommendation is to go slow with policy. The technical issues can get resolved while the target audience gets up to speed on the fundamentals of whole-building LCA. We have highlighted a number of elements that need to be put in place for fair and reliable life cycle assessment in the context of procurement and regulatory policy.

As the visionaries in green building policy and programs move forward in addressing embodied carbon, a few organizations are working hard in the background to create the technical underpinning needed to support robust and effective embodied carbon policy.

We’re excited about the growing momentum in this area. Technical or advocacy efforts are happening at the National Research Council Canada, the MIT Concrete Sustainability Hub, and the Embodied Carbon Network, among others.

At the Athena Institute, this is at the core of what we do. Our work has enabled LCA provisions already in place in green building programs. To support more ambitious emerging LCA-based policy, we are currently active on several elements of the technical infrastructure:

---

• Developing whole-building LCA guidelines (with an emphasis on standardizing how to compile and catalogue a bill of materials), to be applicable for all WB-LCA software tools and to support benchmarking.

• Developing the infrastructure for benchmarking, beginning with a bill of materials benchmark database, to be applicable for all WB-LCA software tools.

• Continued advancements to our free WB-LCA software tool (the Impact Estimator for Buildings), with an emphasis on creating a web version and enabling third-party software interoperability.

• Participation in the Canadian LCA^2 initiative, which will lead to a national LCI database and other resources and will perhaps eventually extend to include the US.

• Continued efforts to fill some of the outreach and education gaps.

It may seem like a big hill to climb, but it’s do-able with the strong, committed collective effort gathering steam lately. Jordan Palmeri, a policy thought leader with the Oregon state government, puts it well: “The good news is that we’re all aiming for the same goal here – to reduce the environmental impacts of buildings and building materials.”